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SISYRINCHIUM: ANATOMICAL STUDIES OF NORTH AMERICAN SPECIES

THEO. HOLM

(WITH PLATES X, XI, XI A)

Before the genus Sisyrinchium becomes entirely lost in segregates and in new species, which in late years have accumulated very rapidly, it might be appropriate to present some notes to demonstrate the characteristics of the genus as represented within our own boundaries.

Three sections are recognized by BENTHAM and HOOKER: BERMUDIANA Adans., ECHTHRONEMA Herb. (HYDASTYLUS Salisb.), and ERIPHILEMA Herb., based on floral structure, and especially whether the filaments are connate for their entire length or only partly so. In his work on the *Botany of California* WATSON reached the same conclusion, and considered these floral characters as being merely of sectional importance. But in late years some American writers have raised these sections to generic rank, though with the preference of Sisyrinchium for Bermudiana, and Hydastylus for Echthronema, and without having invented any other distinctive characters than the floral, already described by BENTHAM and HOOKER, and by WATSON. In fact the habit of these plants is very much alike; and strikingly so when compared with Iris, in which genus the floral structure exhibits no small modification, and besides, the habit is extremely variable; nevertheless Iris has not yet suffered the same dissolution as Sisyrinchium.

The internal structure of the Irideae has already been studied by some authors, but not very extensively, since only the leaves have been examined. ROSS,[1] and CHODAT and BALICKA-IWANOWSKA[2] have published some very interesting anatomical papers dealing with the foliar structure of a large number of genera, but very little has been written in regard to our genus Sisyrinchium. The following notes may thus be considered as supplemental to these papers, but I have included the structure of the stem and root for the sake of making the anatomical diagnosis a little more complete. Moreover, I believe that the internal characters observed in representatives of the three sections mentioned above will strengthen the former view of considering Sisyrinchium as one genus, and a very natural one.

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[1] Anatomia comparata delle foglie delle Iridee. Malpighia 6:1892; and 7:1893.

[2] La feuille des Iridées. Jour. de Botanique. 1892.

The material examined consists of *S. anceps* Cavan., which is very frequent in sandy soil among rocks on the Potomac shore (D. C.); *S. angustifolium* Mill., from sandy hills near Brookland (D. C.); *S. montanum* Greene, from gravelly soil along creeks on Long's Peak (Colorado), at an elevation of about 9000 feet; *S. xerophyllum* Greene, which I found quite abundant in low pine barrens near Eustis (Florida); *S. grandiflorum* Dougl., from dry hillsides in Oregon; and *S. californicum* Ait. f. from swamps at Bodega (Cal.). The last two species were kindly sent to me by Miss ALICE EASTWOOD and Mr. THOMAS HOWELL. To these may be added the tuberous-rooted *S. alatum* Hook. from lava fields above Cuernavaca, Morelos, Mexico, at an elevation of 8500 feet, collected by Mr. C. G. PRINGLE.

As stated above, the general habit of these species is very much the same, especially the inflorescence. This represents in our species of Sisyrinchium a rhipidium,[3] and this type of monochasium is frequent among the Irideae. Whether the inflorescence is single and terminal or accompanied by a lateral, the flowers are always surrounded by green, leaflike bracts (L, L^1, and L^2, *fig. 2*); a membranaceous foreleaf occurs at the base of the lateral inflorescence (P, *fig. 2*) and at the base of the axillary flowers (P^1–P^3, *fig. 6*). The successive development of the flowers may be seen in the diagram (*fig. 6*), where five flowers (*1–5*) are situated in the same plane, and where *1* is the terminal, the earliest developed. The various stages of these flowers are shown in *figs. 3–5*, but the two bracts (L^1, L^2) are only indicated. The stamens, especially the anthers (*St*, *figs. 4, 5*), are much farther advanced than the outer (P^1) and inner perianth leaves (P^2). I have found no deviation from this type of inflorescence in any of the three sections, but the relative length of the green bracts (L–L^2, *fig. 2*) varies very much, and is considered as a specific character, with no good reason, however. Bracts and foreleaves, as we know, are very frequently subject to variation, sometimes in accordance with the surroundings

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[3] Compare EICHLER, Blüthendiagramme 39. *fig. 20A.*

The rhizome is usually very short and cespitose, but in some species, *S. californicum* for instance, the rhizome is horizontally creeping, with the internodes quite distinct. The leaves are two-ranked, equitant, and the aerial stems strongly compressed, except in *S. grandiflorum,* in which leaves and stems are almost cylindric. It would be interesting to know whether the species of these three sections germinate in the same way, but so far this point does not seem to have been studied. For this reason I have followed *S. angustifolium,* which is so very frequent in the vicinity of Brookland, from seedling to mature plant, and the structure of the seedling is as follows. The cotyledon (*Cot, fig. 1*) is epigeic and consists of a sheathing base and a long filiform blade, the apex of which remains inclosed within the seed for some time, as shown in the accompanying drawing. Three leaves (L^1–L^3) are developed from the plumule during the first season, and the structure of these leaves agrees with that of the later ones, being ensiform and green. The primary root (*R*) grows and remains active during the first season, and becomes ramified; secondary roots (*r*) develop also, and these proceed from the base of the cotyledon. It requires several years for the plant to reach the flowering stage, and until then the small rhizome remains as a monopodium similar to Iris. This method of germination represents KLEBS' type 5,[4] and corresponds, to some extent, with that most frequent among the dicotyledons where the seed leaves are epigeic. It is characteristic of several Liliaceae (Allium, Bowiea, Asphodelus, etc.) and of Agave, but not of Iris; in *I. Pseudacorus,* for instance, the apex of the cotyledon remains inclosed within the seed, and does not become free as in Sisyrinchium. So far as the external structure of the various members of the three sections mentioned above is concerned, there seems no plausible reason for dividing the genus, and we shall see that the internal structure also does not warrant any such segregation. Whatever distinctive characters have been observed are merely sectional, and it is hardly necessary to call attention to the fact that much more pronounced deviations in structure are known in many other genera, which so far have been left intact.

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[4] Beiträge zur Morphologie und Biologie der Keimung. Untersuch. Bot. Inst. Tübingen 1:572. 1881–1885.

Anatomically our genus is not a very interesting one, but the structure has never been studied, and I thought that the following discussion of the vegetative organs might be of some interest from a comparative point of view. Some knowledge of the structure, especially since the material came from widely separated stations, may be of interest to students of plant societies, for it seems to me that many of the conclusions reached in the name of ecology are too superficial, so long as the plants themselves have not been studied thoroughly.

ROOTS

In our native species of Sisyrinchium the secondary roots are slender; they are soft and of a whitish color in *S. californicum*, but quite strong, and yellowish brown in the other species. In *S. xerophyllum* and *S. grandiflorum* the roots are almost villous from the dense covering of root hairs, while in the other species the roots are much less hairy. The epidermis is thin-walled, and inside this is an exodermis of a single stratum, whose cells are mostly pentagonal in cross-sections, and thin-walled in all the species except *S. xerophyllum*, in which the exodermis is very distinctly thickened. The cortical parenchyma contains no stereids, and is composed of a compact, but thin-walled tissue; in *S. montanum* the cortex collapses tangentially, but remains solid in the other species, and contains deposits of starch except in *S. californicum*. The endodermis shows a very pronounced thickening of the inner cell walls, thus representing a U-endodermis, but is thin-walled in *S. californicum*.

The pericambium consists generally of a single layer of thin-walled cells (*P, fig. 8*), and is continuous; however, the following exceptions were noticed. In *S. montanum* (*fig. 9*) there is frequently a second stratum of pericambium to be observed outside some of the hadrome rays and this same condition occurs also in *S. xerophyllum* (*fig. 10*). Sometimes the pericambium becomes thick-walled, as may be seen from *fig. 11*, which is of *S. xerophyllum*, and in which the cells outside the leptome are quite thickened in contrast to those outside the hadrome. In these same figures of *S. xerophyllum* (*figs. 10, 11*) we notice also that the pericambium is not continuous, but interrupted by the protohadrome vessels. This interruption of the pericambium was observed only in this species (*S. xerophyllum*), in all the roots examined, but not in any of the roots of the other species.

The hadrome is very conspicuous in all the roots, and there may be as many as twelve rays with two or three protohadrome vessels in each ray; the leptome, on the other hand, consists of very narrow strands, in which the protoleptome cell is readily visible (*PL, figs. 8–11*). Although the rays of the hadrome extend to the center of the root, the conjunctive tissue, nevertheless, is very conspicuous, and is mostly thin-walled except in *S. xerophyllum* and in some of the roots of *S. anceps*.

This structure seems to be characteristic of the slender secondary roots of mature specimens of this genus. In the corresponding roots of the seedling of *S. angustifolium* no exodermis is developed and the cortical parenchyma is very thin-walled; the endodermis, on the other hand, is very thick-walled, representing a typical U-endodermis. In these young roots the pericambium is continuous, and the stele contains only two hadromatic rays alternating with two small groups of leptome. In regard to the structure of the stele, the pericambium, and the mestome, the thin lateral roots of mature specimens agree with that observed in the secondary ones of the seedling; but the endodermis is different, being thin-walled and showing the Casparyan spots very plainly (*End, fig. 16*).

The structure of the roots of these species is thus very uniform, and the only distinction seems to depend upon the structure of the pericambium, which sometimes consists of more than one stratum, and which may be interrupted by the protohadrome, as observed in *S. xerophyllum* from subtropical Florida.

In the tuberous roots of the Central American *S. alatum* Hook. the cortical parenchyma represents a very large parenchyma filled with starch, and with the cell walls thickened; but otherwise the structure of epidermis, exodermis, endodermis, and pericambium, which is continuous, is identical with that of the species described above. The number of hadromatic rays averages about twelve, and the leptome occurs as exceedingly narrow strands in these tuberous roots.

RHIZOME

S. californicum is the only species examined that possesses a horizontally creeping rhizome with the internodes distinct. The structure is rather weak when compared with that of the rhizomes of the monocotyledons in general, since no stereome is developed. The epidermis is thin-walled and covers a cortex of broad, compact parenchyma; the endodermis is thin-walled, and the cells somewhat irregular in shape. Inside the endodermis is a large, thin-walled pith, in which the numerous mestome strands are located, but without being arranged in bands; most of these mestome bundles were observed to be leptocentric, the leptome being more or less completely surrounded by the hadrome.

STEM ABOVE GROUND

With exception of *S. grandiflorum* the stem is ancipital, simple, or sometimes branched above; the wings vary somewhat in breadth, but the central portion of the stem is always cylindric, and of a very firm structure, due to the presence of a solid sheath of thick-walled stereome. The cuticle is frequently thick and wrinkled, and cell walls of the epidermis are prominently thickened, especially the outer, and very often extended into short papillae, but not in *S. californicum*. In the body of the stem as well as in the wings the cortex is composed of palisades and represents a very compact tissue, but in *S. californicum* the cortical parenchyma is more open and the cells very short, almost roundish in transverse sections. There is no hypodermal collenchyma or stereome in any of these species, and the stereome constitutes, as stated above, a closed sheath of several strata located on the inner face of the cortex in the cylindric portion of the stem; in the wings the stereome accompanies the larger mestome strands as small groups on the leptome side. The mestome bundles are arranged in two concentric bands in the cylindric part of the stem, but in a single plane in the wings. They are collateral, and those of the peripheral band are very small, and contain mostly leptome; they are located in the cortex, but their hadrome touches the stereomatic sheath. Those of the inner band are much larger and are located directly inside the stereome cylinder, with their hadrome bordering on the pith. The innermost part of the cylinder is occupied by a pith, which is frequently somewhat thick-walled and solid. In the wings the mestome strands are few, and they show mostly the same position of the hadrome, which is turned toward the center of the stem; it is only the marginal mestome strands that differ in this respect, the leptome and hadrome being vertical on the surface of the wings, instead of parallel.

In *S. grandiflorum* the structure of the stem is somewhat different; the outline is less compressed and there are many deep furrows. These furrows contain cortical parenchyma, and the peripheral band of small mestome bundles is located in the ridges, thus imbedded in the cortex and removed from the stereomatic sheath. The inner band of mestome bundles, on the other hand, is located inside the stereome, as in the other species described above.

The structure of the stem is thus very uniform in these species of Sisyrinchium, and it seems characteristic of the genus that no hypodermal mechanical tissue is developed; that there is a strong sheath of stereome separating two concentric bands of mestome bundles, of which the peripheral are of the same size and much smaller than the inner ones; furthermore, the winged stem of most of these species constitutes also a very conspicuous feature.

LEAVES

The foreleaves are membranaceous, almost destitute of chlorophyll, and strongly compressed from side to side; they are frequently scabrous from thick-walled papillae (*fig. 12*), but only on the dorsal face. The cuticle is smooth, and the epidermis is moderately thick-walled on the dorsal face, but thin-walled on the ventral. There is only chlorenchyma in the middle portion of these leaves, and it consists of roundish cells throughout, with very little chlorophyll; the broad and very thin margins of the foreleaves consist only of epidermis, that of the dorsal face. The stereome is very poorly represented; it occurs as two very small, hypodermal strands, one on each side of the ventral sinus above the midrib, and the veins have a few layers of this tissue on the hadrome side. There are several mestome strands in these leaves (3 to 8) and the midrib is usually a little thicker than the others; the mestome strands are collateral, and surrounded by parenchyma sheaths. While the leptome is well developed in all the veins, the hadrome is frequently absent, except in the midrib.

The green leaves are sheathing, and provided with a long, strongly compressed blade, the structure of which is very markedly isolateral. By examining the anatomical structure of the blade one gets the impression that the peculiar position of the leptome and hadrome in the veins is due to a concrescence of the two halves of the leaf-blade, resulting in a more or less complete suppression of the morphologically ventral face of the blade.

However, the development of the ensiform leaf of Irideae, as described by GOEBEL,[5] teaches us something very different. According to this author the singular shape and structure of the blade is caused not by a concrescence of the two halves of the blade, but by the peculiar growth of the leaf-primordium. The young leaf becomes laterally compressed at a very early stage of its development, and it so happens that its dorsal face shows this flattened growth much more than the ventral. The real growing-point soon ceases to be active, while a new point takes its place and this is located on the extreme back of the primordium, and somewhat lower than the original. The leaf thus shows two apices, and the secondary of these grows out into a long bladelike organ, which consequently has no ventral face, and in which the arrangement and structure of the veins must follow other laws than in a normally developed leaf-blade. The real apex of the leaf is thus to be found at the upper part of the open sheath, while the bladelike organ represents merely a secondary growing-point, which has surpassed the primary one.

In the species of the section BERMUDIANA the leaf-sheath is usually much shorter than the ensiform blade; in the section ECHTHRONEMA, on the other hand, the sheath may be traced to very near the apex of the blade; and finally, in the section ERIPHILEMA the blade is less compressed and often much shorter than the open, sheathing portion of the leaf. It is interesting to see that although the leaves are ensiform in all these species, the internal structure nevertheless exhibits two types so far as concerns the disposition of the mestome strands, which are in a single plane, as in BERMUDIANA, or in two parallel planes, as in the two other sections. But otherwise the structure is rather uniform, and the few distinctions which I have observed seem to be of merely specific importance.

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[5] In SCHENK'S Handbuch der Botanik 219. Breslau. 1884.

Beginning with section BERMUDIANA, the leaf-blade is smooth in *S. anceps*, but furrowed longitudinally in several of the other species, as *S. angustifolium*, *S. bellum*, etc. The surface varies from perfectly glabrous to very prominently scabrous, and it deserves notice that the leaves may exhibit both structures when examined at different places. The apex may be very scabrous, for instance, in contrast with the lower parts of the blade, or sometimes *vice-versa;* or some of the earliest developed leaves may be more glabrous than the succeeding. I mention this since the characters "glabrous" and "scabrous" figure so very conspicuously in the recently published diagnoses of "new species of Sisyrinchium."

The cuticle is thick and distinctly wrinkled. The epidermis is frequently thick-walled, especially the outer walls (*figs. 13, 15, 20, 21*), and, as stated above, the extension of epidermis into papillae of various forms, pointed or obtuse, is common to several members of the genus (*fig. 21*).

The stomata are arranged in longitudinal lines on both sides of the blade, and they are sunk (*fig. 13*). It is interesting to notice that in the subtropical *S. xerophyllum* (from Eustis, Florida) the thickness of epidermis reaches its maximum (*fig. 15*); the cell walls are extremely thick and porous, but no papillae were observed in this species.

In regard to the chlorenchyma, we have in this section a more or less typical and compact palisade tissue of several layers, the innermost of which forms circular bands around the mestome bundles, with the cells radiating toward the center; while in the peripheral (hypodermal) strata the palisade cells are vertical to the epidermis. In some species, for instance *S. anceps* and *S. xerophyllum*, the chlorenchyma breaks down and forms lacunes between the veins, especially in the latter species. The mechanical tissue in the genus is only represented by stereome, which accompanies the mestome bundles as a small cover on the leptome and hadrome side; but it is not very thick-walled except in *S. xerophyllum*, and it does not occur as isolated, hypodermal groups in any part of the leaf. It occupies the somewhat unusual position of being located inside the thin-walled, chlorophyll-bearing parenchyma sheath, which surrounds each of the mestome strands. However, this parenchyma sheath differed from similar sheaths in other monocotyledons by showing no resistance when treated with concentrated sulfuric acid.

The arrangement of the mestome strands is very peculiar, and especially the disposition of leptome and hadrome. From the fact that the blade is not a blade in the proper sense of the word, but an outgrowth of the dorsal face, hence with no ventral face developed, the course of the veins is different from that of leaves in general. If we examine a cross-section of the blade we notice at once that all the mestome strands occupy a single plane, extending from the one margin of the blade to the other; also that the mestome strands show a different position of leptome and hadrome in relation to the periphery of the section. Those near the center of the blade are the largest, and in these the leptome turns alternately with the hadrome to the right or left of the longitudinal axis of the leaf; in this way, by examining the two sides of the leaf, we find in one mestome strand the leptome turned toward the right, in the next toward the left, etc.; and the same alternating position is of course also occupied by the hadrome. But the small strands, which are located in the thin margins of the blade, show almost constantly the leptome turning toward the edge of the leaf, and the hadrome, on the contrary, toward the center. In other words, the structure of the blade looks as if the two halves had grown together, but we know from the development of the leaf-primordium that no such concrescence has taken place. The mestome bundles are collateral and show the ordinary structure; anastomoses are not infrequent, and they form very acute angles with the larger veins, as in Eriocaulon for instance. The leaf structure is thus very uniform in this section, and the most conspicuous variation seems to depend upon the thickness of the epidermis, and upon whether the chlorenchyma forms typical palisades (*fig. 20*), or consists of short, almost roundish cells, as in *S. anceps* (*fig. 21*).

In *S. grandiflorum* (section ERIPHILEMA) the leaf structure differs very conspicuously from that of the former section, and resembles much more the structure of a stem than of a foliar organ. In this species the leaf is less compressed; the mestome strands constitute a narrow elliptical band, instead of being located in a single plane;

also the central portion of the leaf contains a thin-walled, colorless tissue very much resembling the pith of a stem, and is frequently hollow. Otherwise the structure of the tissues is identical with that of several species of the former section (BERMUDIANA). The cuticle is thick, but smooth; the epidermis is papillose, moderately thick-walled, and the chlorenchyma is composed of palisades, which are vertical to the epidermis but very open from wide intercellular spaces. The stereome is rather thin-walled, and shows the same distribution as in BERMUDIANA. The leaf is very distinctly furrowed longitudinally, and the mestome strands, which are of two sizes, are arranged alternately so that the smaller are in the furrows and the larger in the ridges. All the mestome strands turn the leptome toward the periphery of the blade, while the hadrome borders on the thin-walled parenchyma, which fills the innermost portion of the blade, thus resembling a pith in respect to structure and position.

In the section ECHTHRONEMA the principal structure of the blade agrees better with that of ERIPHILEMA than of BERMUDIANA; because the mestome strands are here also in a very narrow elliptical band with the hadrome turned inward and bordering on a central, thin-walled parenchyma. In *S. californicum* the cuticle is thin and smooth; the epidermis is relatively thin-walled and perfectly glabrous. The chlorenchyma (*fig. 18*) shows no palisades, but is composed of a homogeneous tissue of oblong to roundish cells (in cross-section); however, a superficial section of the blade (*fig. 17*) shows the cells of the chlorenchyma very distinctly stretched and lobed, not parallel with the longitudinal axis of the leaf, but vertical to it. In this way the chlorenchyma shows actually the structure of a pneumatic tissue, as this is developed in the dorsal portion of leaves; the central part of the chlorenchyma in this species is also a colorless, thin-walled parenchyma. No stereome was observed, and the mestome bundles are in a narrow elliptical band; they are collateral and surrounded by thin-walled parenchyma sheaths.

This is in brief the anatomical structure of these species of Sisyrinchium, and bearing in mind that representatives of each of the three sections have been examined, it appears to me that the genus is a very natural one, and that it ought not to be divided. In regard to the morphological structure of the shoot, I have not been able to detect any character that seems peculiar to these sections; on the contrary, the rhizome, the leaves, and the inflorescence are very uniformly developed, and the only distinction depends upon the floral structures which were mentioned in the introduction. If these floral structures were accompanied by differences in the development of the shoot, and also by peculiarities in the internal structure, there might have been some reason for dividing the genus. There are several very peculiar looking species in Mexico, and these ought to be examined anatomically from fresh material. Until then it seems most advisable to leave the genus intact.

Finally, I wish to add a few words in reference to the structure of the chlorenchyma in other genera of the Irideae. We have seen the chlorenchyma in the sections BERMUDIANA (*fig. 19*) and ERIPHILEMA is more or less differentiated as palisades, while in ECHTHRONEMA this tissue is composed of oblong cells parallel with epidermis; moreover, that the cells in ECHTHRONEMA are lobed, resembling those of a pneumatic tissue. These structures occur also in other genera, and for the sake of making a comparison I examined some of them. In Iris, for instance, we find in *I. cristata* Ait. (*fig. 22*) a structure of the chlorenchyma which corresponds well with that of *Sisyrinchium californicum*, but the cells of which are branched rather than lobed, thus representing a typical pneumatic tissue. In *Iris verna* L. and *I. fulva* Ker., on the other hand, there are typical palisades, which, however, show the same direction, being parallel with the epidermis and vertical to the longitudinal axis of the blade; in *I. xiphioides* Ehrh. the palisades are vertical to the epidermis. A structure that corresponds with that of *Iris verna* is furthermore characteristic of *Tapeinia magellanica* Juss., *Freesia refracta* Klatt., and *Tritonia* sp. In *Belamcanda chinensis* Adans. the chlorenchyma has a very irregular structure, the cells varying from oblong and entire to more or less deeply lobed. We have thus in Iris as varied a development of the chlorenchyma as was observed in Sisyrinchium.

I have also pointed out the somewhat peculiar arrangement of the mestome strands in Sisyrinchium (the single plane in BERMUDIANA, and the narrow elliptical band in ERIPHILEMA and ECHTHRONEMA). That such variation in the position of the mestome bundles is also observable in other Irideae may be seen from the descriptions and figures in the work of ROSS cited above. It is really surprising to see the polymorphic structure possessed by Iris. In *I. alata* Poir. the leaves are perfectly open, not ensiform, and the veins show exactly the same position as in a typical linear leaf of grasses, for instance; in species with ensiform leaves we notice in *I. foetidissima* L. the mestome strands forming a narrow ellipse; in *I. juncea* Desf. they are arranged in an almost circular band; in *I. reticulata* M. B. the band is quadrangular; and finally in *I. japonica* Thunb. the structure is like that of section BERMUDIANA. A very striking variation occurs in Gladiolus, where the outline of the section varies from linear to cross-shaped with a corresponding variable position of the mestome strands. These modifications in structure are very striking, and moreover they are in several cases accompanied by distinct external characters, floral or vegetative; nevertheless they are not looked upon as being of anything but specific importance, an opinion which no doubt is the most natural.

In regard to the almost untold number of recently described "species" of Sisyrinchium, I have examined the internal structure of some of these, but so far have failed to detect any character that might appear specific; and moreover it seems very evident, when the diagnoses of the majority of these are read, that they deal not with "species" but merely with "local forms."

BROOKLAND, D. C.

EXPLANATION OF PLATES X, XI, XI A

PLATE X

FIG. 1.—*S. angustifolium:* seedling, showing cotyledon (*Cot*) with seed still attached; *R*, primary root; *r*, secondary roots; L^1–L^3, the first leaves succeeding the cotyledon. Natural size.

FIG. 2.—*S. anceps:* young inflorescence; L–L^2, green bracts; *P*, foreleaf of axillary inflorescence. Natural size.

FIG. 3.—*S. anceps:* inflorescence, the terminal of *fig. 2;* P^1–P^2, foreleaves; L^1–L^2, green bracts. Magnified.

FIGS. 4, 5.—*S. anceps:* two youngest flowers of same inflorescence; P^1, outer, P^2, inner perianth; *st*, stamens. Magnified.

FIG. 6.—*S. anceps:* diagram of a five-flowered inflorescence; *1–5*, the flowers, of which *1* is the first developed; the other letters as above.

FIG. 7.—*S. alatum:* cross-section of root; *C*, cortex; *End*, endodermis; *P*, pericambium; three rays of hadrome and two strands of leptome are figured. ×320.

PLATE XI

FIG. 8.—*S. anceps:* cross-section of root; *PH*, protohadrome; *PL*, protoleptome; the other letters as in *fig. 7*. ×496.

FIG. 9.—*S. montanum:* cross-section of root stele; letters as above. ×496.

FIG. 10.—*S. xerophyllum:* cross-section of root stele; letters as above. ×496.

FIG. 11.—*S. xerophyllum:* cross-section of root stele; *V*, vessels; the other letters as above; many of the pericambium cells are thick-walled. ×496.

FIG. 12.—*S. angustifolium:* epidermal projection from the foreleaf. ×240.

FIG. 13.—*S. angustifolium:* cross-section of the stoma from the leaf. ×496.

FIG. 14.—*S. angustifolium:* a stoma seen from above. ×496.

FIG. 15.—*S. xerophyllum:* cross-section of leaf; *C*, cuticle; *Ep*, epidermis. ×496.

PLATE XIA

FIG. 16.—*S. montanum:* cross-section of a thin lateral root; letters as above. ×496.

FIG. 17.—*S. californicum:* chlorenchyma of leaf, seen from above.

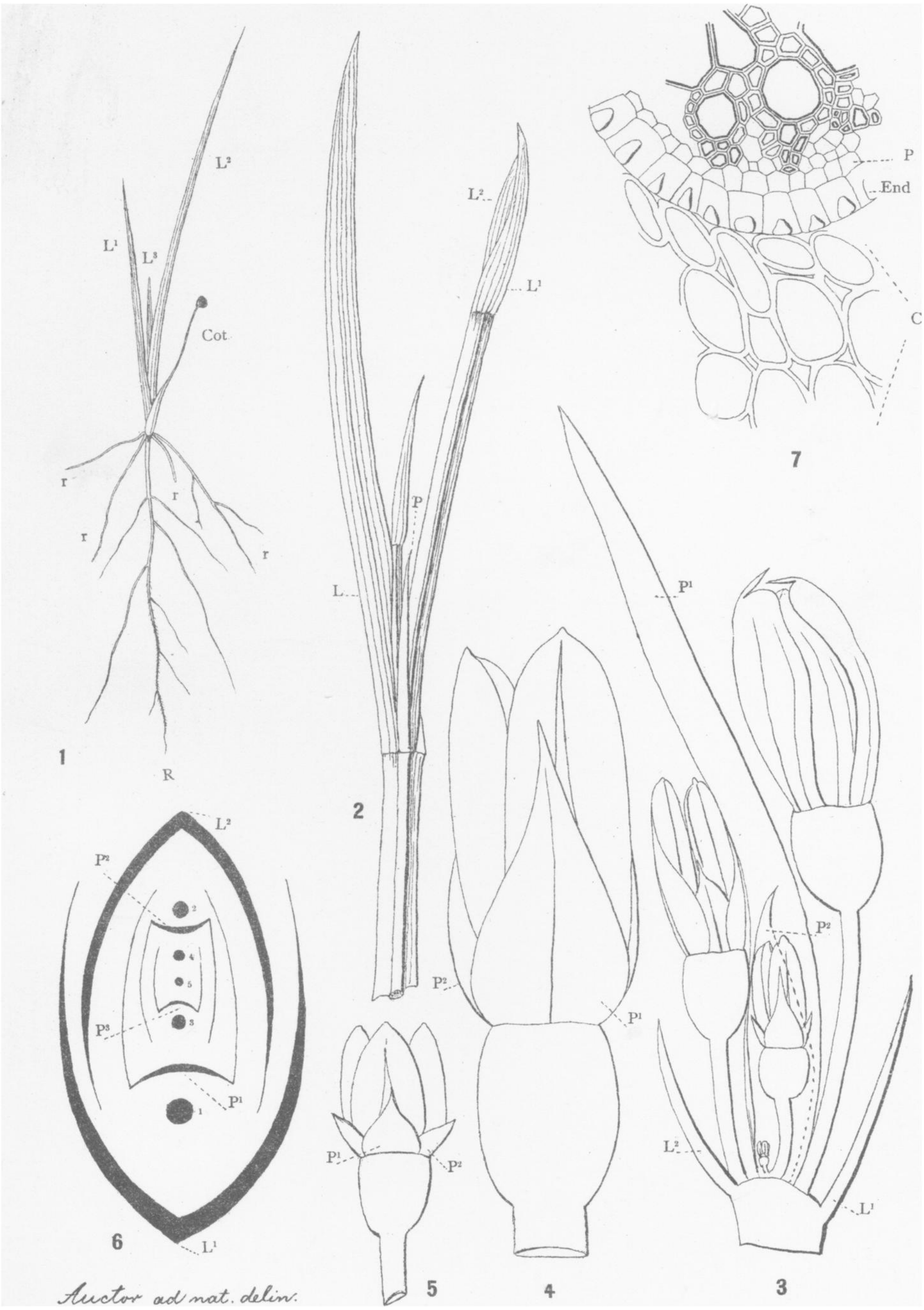
FIG. 18.—*S. californicum:* cross-section of part of leaf; *Ep*, epidermis; *PS*, parenchyma sheath of mestome strand.

FIG. 19.—*S. montanum:* chlorenchyma of leaf, seen from above. ×240.

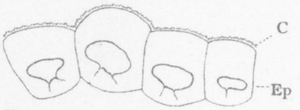
FIG. 20.—*S. montanum:* cross-section of part of leaf; *St*, two stomata with their air chambers (*A*); the other letters as in *fig. 18*. ×320.

FIG. 21.—*S. anceps:* cross-section of part of leaf; *Ep*, epidermis; both leptome and hadrome have a support of stereome. ×496.

FIG. 22.—*Iris cristata:* chlorenchyma of leaf, seen from above. ×240.



HOLM on SISYRINCHIUM



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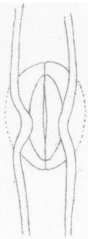

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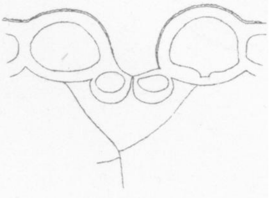

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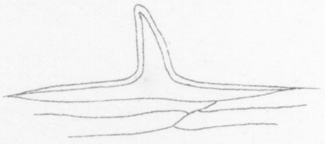

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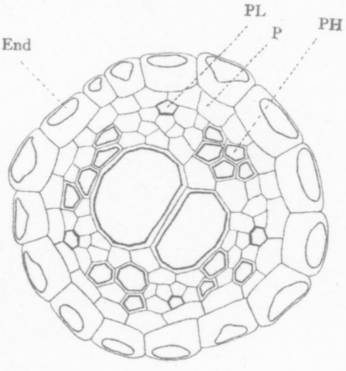

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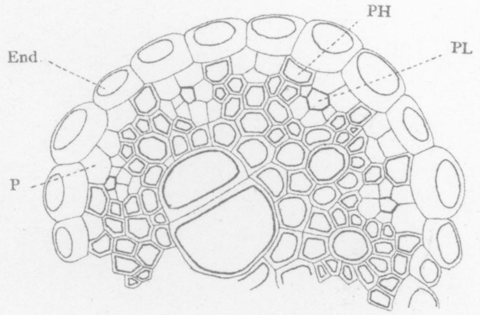

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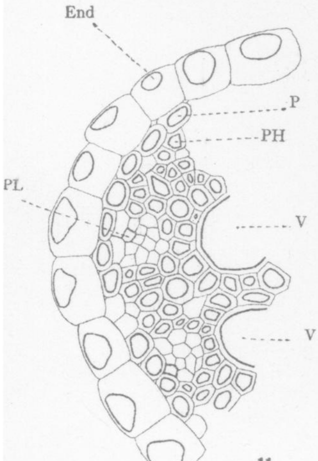

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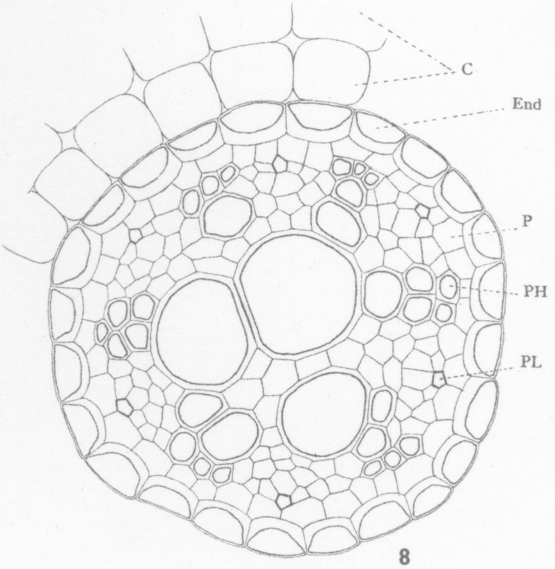

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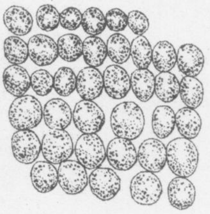
Auctor ad nat. delin.

HOLM on SISYRINCHIUM



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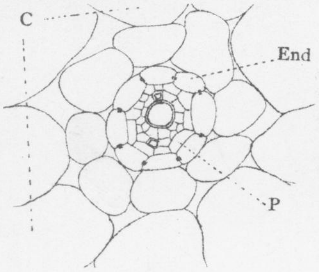

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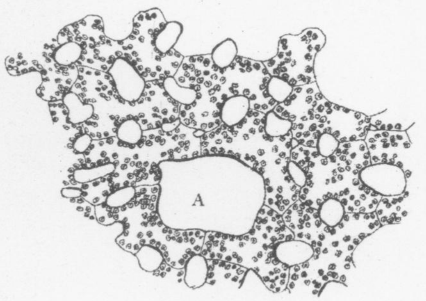

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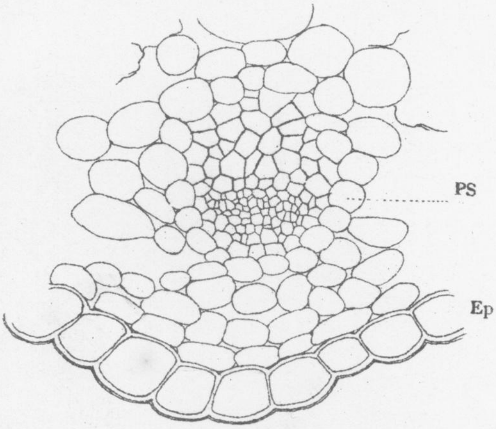

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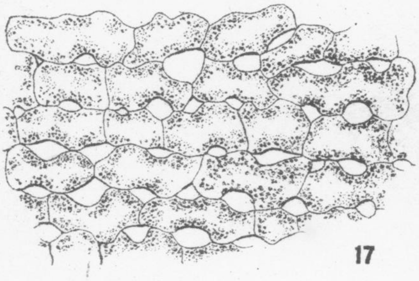

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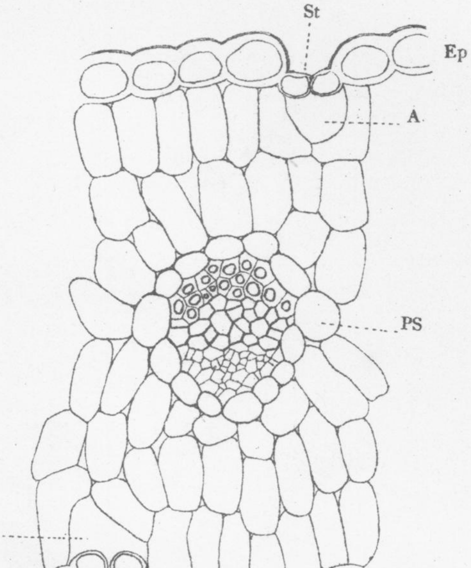

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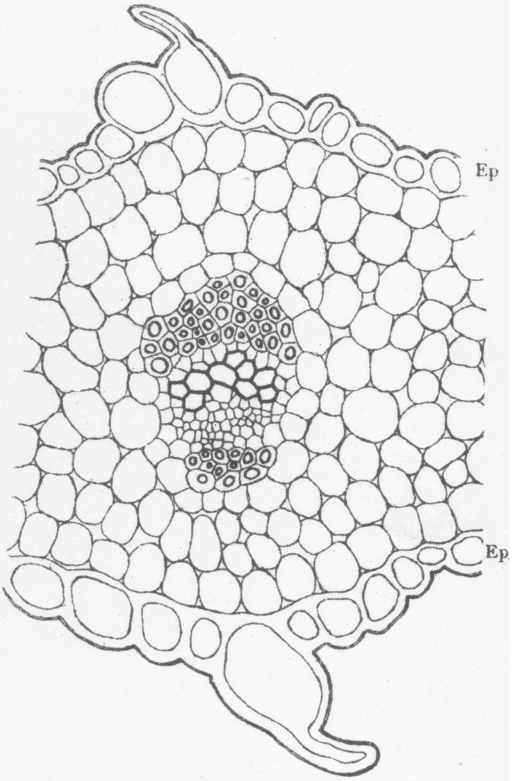

21

Auctor ad nat. delin.

HOLM on SISYRINCHIUM.